

ASSESSMENT OF ALUMINIUM METAL MATRIX COMPOSITES – REVIEW

P BERLIN PUSH¹ & Dr. B BAVANISH²

¹Research Scholar, Noorul Islam Centre for Higher Education, India

²Associate Professor, Noorul Islam Centre for Higher Education, India

ABSTRACT

The mechanical properties of the metal matrix composites are superior to the wide range of composites used in various operating conditions. For different engineering applications, these composites have replaced many metals because of its updated properties. This article discusses the review of Aluminium Metal Matrix Composites (AMMC) machining and the enforced synthesis of its composites. This article also attempts to elaborate the recent works that is being conducted on the AMMC. For making the machining process economical, selecting the suitable machine parameters is used.

KEYWORDS: Aluminium Metal Matrix Composites, Reinforcement, Cutting Speed, Feed, Depth of Cut, Surface Finish & Mach Inability

Received: Feb 16, 2020; **Accepted:** Mar 6, 2020; **Published:** Mar 06, 2020; **Paper Id.:** IJMPERDAPR2020108

1. INTRODUCTION

Now a days, a lot of research is being implemented for the development of new structural materials having elevated strength to weight ratios. This ratio is one of the challenges in the aerospace and space industry. There are lot of properties which define the Metal Matrix Composites (MMCs) that is being used in many industrial sectors. Improved properties like strength, wear resistance, stiffness have made them one of the most used compounds in the field of material science and that is the key to it. Composite is considered to be the materials which are not soluble in one another and consist of two or more materials and the primary content of these materials is the matrix phase which will provide the structural integrity and will show enhanced mechanical properties. The reinforcement of these materials include the inorganic, organic and metallic polymers. However, mostly used materials which are used for the reinforcement are the fibers or particulates. In recent times, the use of the aluminum and its alloys have gained much more attention which is used as base material in MMCs [1]. Superior properties shown by composite materials have made an option to consider them for replacing the conventional materials which are used in many engineering applications. With better reinforcement addition and the better arrangement of metal matrix, desired properties can be achieved.

The materials included in the Metal Matrix Composites (MMC) are magnesium, titanium and aluminium alloys. There are numerous reinforcing materials in MMC that include boron carbide, short fibers, silicon carbide, graphite and long fibers. Aluminium Metal Matrix Composites (AMMC) include aluminium metal matrix and reinforcement materials such as aluminium oxide, boron oxide etc. This article discusses about the machining of the MMC, mostly the Aluminium metal matrix composites. The important reinforcing components are fibers and they have most influencing constituent that will enhance the properties[1]. Usually, used hybrid reinforcement materials are Zircon because it has high water resistance. The experiments conducted through the fly ash reinforcements have increased because of their availability and low cost. It also helps to increase the electromagnetic shielding effect in

Aluminium Metal Matrix Composites (AMMC).

There is a two step process included, first stage, a dispersion agent is being used and it act as a dispersion agent which will disperse the Multiwall Carbon Nano Tubes (MWNTs) on the magnesium alloy chip. The dispersed MWNTs with the chip were melted and it is stirred continuously [2]. The Mg MWNT is the molten alloy which is then poured in to a mould which help it to solidify quickly. Before the dispersion, these alloys are used to study the morphology using the SEM. With these morphological studies, we can conclude that MWNTs are successfully dispersed on the surface of Mg alloy [3]. With the compression testing of the samples, the mechanical properties of the composites can be studied. These studies have shown much better improvement in MWNTs to the Mg alloy.

2. SILICON CARBIDE REINFORCED AMC

The investigation of the machinability and mechanical properties of silicon carbide particle reinforced Al-MMC has started due to its increased properties. the increase in tensile strength, reinforcement ratio, density and hardness and of aluminium matrix nanocomposite material increased. As these properties have increased, but impact toughness didn't increase, whereas it has decreased. Under different temperature conditions, the behaviour of the aluminium enforced silicon carbide particles is studied. The impact behaviour has been affected because of the clustering of particles. However, with the clustering, weak matrix-reinforcement bond and particle cracking has also occurred [4-6]. All the materials tested shows that the temperature has an effect on the impact behaviour that is very significant for the studies. The fracture behaviour of 7034/SiC/15p-UA and 7034/SiC/15p-PA metal matrix composites. A study of the high cycle fatigue and investigated with these samples. The strength and the ductility of the samples have shown a decrease in microstructure with an increase in temperature.

The investigation of the inability properties of the SiC particle reinforced Al-MMC has done by Tamer Ozbenet al. The factors that have influenced the surface roughness on the machining of Al/SiC particulate composite has been studied by Palanikumar and Karthikeyan [7-9] and [10]. The recommended machining conditions are low cutting speed with high feed rate and depth of cut for rough and medium turning process. Using coated carbide cutting tool, high cutting speed and low feed rate produces better surface finish.

Yanming and Zhou Zehua [11] made some investigation about the tool wear with its mechanism for cutting SiC mints, which have shown that the major damage mechanism is an abrasive wear that has been seen on the tool flank edge for conventional tools and brittle failure for high hardness tools in the cutting the composites. The major factors affecting tool life are volume fraction of SiC and its size in the composite. [13-15]

3. ALUMINIUM OXIDE REINFORCED AMC

The effect of the aluminium oxide in aluminium fractions investigated by Park et al. [19] have found that the larger doping of aluminium oxide has decreased the fracture toughness of matrix material composites. These decrease is caused by the inter-particle spacing between nucleated micro voids. A high cycle fatigue behaviour of 6061 Al-Mg-Si alloy reinforced aluminium oxide was investigated by Park et al. [20]. It was studied with the volume fraction between 5% and 30%. Powder metallurgy strength of the processed composite was higher than that of the unreinforced alloy and liquid metallurgy processed composite.

4. BORON CARBIDE REINFORCED AMC

Aluminum metal matrix composites affect the strength. This result shows that nanocomposites of matrix of aluminum contain several properties in crystalline and amorphous. The properties are described in different constituents and distribution, then concentration. Aluminum metal matrix composites made of different methods are described as Hot Isocratic Pressing (HIP) followed by high strain rate forging (HSRF)[15-18], (2) HIP. Some mechanical properties are present in QIF, its attribute to inhibition re crystallization and high stain. Other important methods were also described in taguchi method. This one characterizes to explain the surface and metal matrix quality. Feed rate and cutting speed is the very important significant for surface characteristics. The major application of SiC and B₄C also the experiments reinforced to used MMC.

5. FIBER RE INFORCED AM C

Aluminum and stainless steel fibers are stress analysis in 600°C the matrix and fiber contain good bonding. Elastic-plastic thermal stress is also used to the composites that are reinforced and recycled by residual stress and plastic strain. Its highest percentage of plastic yielding, cycle fatigue behavior of the pure Al used to the fatigue and strain amplitudes and temperatures are analyzed. Aluminum alloy and short fiberreinforced 6061Al alloy MMC deformer matrix regions allowed to the plastics are deformation and and the density used to temperatures are analysed in work hardening laminated Carbon fiber reinforced 7075-T6Aluminiumalloya stress rate and temperature[21-23] and the debris of fiber fractures are increase. It is determined by the temperature and flow rate of the compressive deformation behavior and direction also equal to monolithic alloy. Sometime, the composite rate also increases in the transient heating the morphologicalSaffil/SiC/Al is a properties of high temperature and lubricated condition and resistance are similar.

Liquid State Fabrication Route

Table 1

S. No	MMC Fabrication Route	Inference	Applications	Cost Aspects
1.	Stir casting	Depends on material properties and process parameters. Suitable for particulate reinforcement in AMC.	Applicable to large quantity production. Commercial method of producing aluminium based composites. [8]	Least expensive
2.	Squeeze casting	Pertinent applicable to any type of reinforcement and suitable for mass production.	Used in automotive industry and aeronautical industry for producing different components like pistons, connecting rods, rocker arms, cylinder heads, front steering knuckle, cylindrical components etc[9]	Moderate
3.	Compo casting (or) Rheocasting	Apt for discontinuous fibres, particularly suitable for particulate reinforcement. Lower porosity is observed.	Used in automotive, aerospace industry, manufacturing industry.	Least expensive
4.	Liquid metal infiltration	Filament type reinforcement normally used.	Production of tubes, rods, structural shapes and structural beams. [11]	Moderate/ Expensive
5.	In-situ (reactive)	Good reinforcement/	Automotive applications.	Expensive

	processing	matrix compatibility, homogeneous distribution of the reinforcing particles.		
6.	Spray casting	Particulate reinforcement used and used to produce full density materials	Cutting and grinding tools, electrical brushes and contacts.	Moderate
7.	Ultrasonic assisted casting	Nearly uniform distribution and good dispersion	Mass production and net shape fabrication of complex [12]	Expensive

Solid State Fabrication Route

Table 2

S.No	MMC Fabrication Route	Inference	Applications	Cost Aspects
1.	Powder Metallurgy (PM route)	Both matrix and reinforcements used in powder form. Best for particulate reinforcement.	Production of small objects (especially round), bolts, pistons, valves, high-strength and heat-resistant materials. Vast applications in automotive, aircraft, defense, sports and appliance industries. [24]	Moderate
2.	Diffusion bonding	Handles foils or sheets of matrix and filaments of reinforcing element.	Manufacture sheets, blades, vane, shafts, structural components.	Expensive
3.	Vapour deposition techniques	PVD coatings are sometimes harder and more corrosion resistant than coatings applied by the electroplating process.	Aerospace, Automotive, Surgical/Medical Dies and moulds for all manner of material processing. Cutting tools, Firearms Optics Watches, Thin films (window tint, food packaging, etc.)	Moderate
4.	Friction Process	Stir	Used as surface modification process. Increase in micro hardness of the surface, significant improvement in wear resistance. [15]	In Automotive and Aerospace applications. Moderate/ Expens

6. CONCLUSIONS

The paper has described a literature to evaluate on machining of particulate Aluminium steel matrix composites.

Tremendous tries have been made in the machining of AMMCs. The method stays nevertheless challenging due to the distribution and orientation of reinforcement in the matrix and non-homogeneous and anisotropic nature of composite as a whole. By suitably selecting the machining parameters, machining of AMMC can be made least costly. This show gives the views, theoretical and experimental effects obtained and conclusions made through the years by means of varies investigators in the area of aluminium alloy – MMCs. A significant amount of interest in Al-MMCs evinced by way of researchers from teachers and industries has applied in conduction of different research and has enriched our understanding approximately the preparing of Aluminum Alloy composites, their physical homes and mechanical houses.

REFERENCES

1. D.L. McDanel // *Metall. Trans. A* 16 (1985) 1105. [2] Tamer Ozben, Erol Kilickap and OrhanCakir // *Materials processing technology* 198 (2008) 220-225.
2. SedatOzden, Recep Ekici and Fehmi Nair // *Composites: Part A* 38 (2007) 484.
3. T.S. Srivatsan, Meslet Al Hajri and V.K. Vasudevan // *International Journal of Fatigue* 27 (2005) 357.
4. MaikThunemann, OlivierBeffort, Simon Kleiner and Ulrich Vogt // *Composites Science and Technology* 67 (2007) 2377.
5. D. Sujan, Z. Oo, M.E. Rahman, M.A.
6. Maleque and C.K. Tan // *Engineering and Applied Sciences* 6 (2012) 288.
7. Zhang Peng and Li Fuguo // *Rare Metal Materials and Engineering* 39 (2010) 1525.
8. S. Tzamtzis, N.S. Barekar, N. Hari Babu, J. Patel, B.K.Dhindaw and Z. Fan // *Composites: Part A* 40 (2009) 144.
9. R. Palanikumar R. Karthikeyan // *Materials and design* 28 (2007) 1584. [10] Inan // *Materials Processing Technology* 164-165 (2005) 862.
10. Quan Yanming and Zhou Zehua // *Materials processing technology* 100 (2000) 194.
11. B.G. Park, A.G.Crosky and A.K.Hellier // *Composites: Part B* 39 (2008) 1270.
12. B.G. Park, A.G. Crosky and A.K. Hellier // *Composites: Part B* 39 (2008)1257.
13. Abhishek Kumar, Shyam Lal, Sudhir Kumar Noida, In: *JMRTEC-40 (WHERE,WHEN)*, [15] G.Abouelmagd // *Materials Processing Technology* 155 (2004) 1395.
14. Bo Yao, Clara Hofmeister, Travis Patterson, Yong-ho Sohn, Mark van den Bergh, Tim Delahanty and Kyu Cho // *Composites: Part A* 41 (2010) 933.
15. R.G. Vogt, Z. Zhang, T.D. Topping, E.J. Lavernia and J.M. Schoenung // *Materials Processing Technology* 209 (2009) 5046.
16. T.S. Mahesh Babu, M.S. Aldrin Sugin and Dr.N.Muthukrishnan // *Procedia Engineering* 38 (2012) 2617.
17. O. Sayman, H. Akbulut and C. Meric // *Composites and Structures* 75 (2000) 55.
18. . OnurSayman // *Composite structures* 53 (2001) 419.
19. CesimAtas and OnurSayman // *Composite Structures* 49 (2000) 9.
20. H.Z. Ding, H. Biermann and O. Hartmann // *International Journal of Fatigue* 25 (2003) 209.
21. H.Z. Ding, H. Biermann and O. Hartmann // *Composites Science and Technology* 62 (2002) 2189.
22. [24]Woei-ShyanLee, Wu-Chung Sue and Chi-Feng Lin // *Composites Science and Technology* 60 (2007) 1975.

23. M. Gudena and I.W. Hall // *Computers and Structures* 76 (2000) 139.
24. J. Shi, R.C. Che, C.Y. Liang, Y. Cui, S.B. Xu and L. Zhang // *Composites: Part B* 42 (2011) 1346. Hui-Hui Fu, Kyung-Seop Han and Jung-Il Song // *Wear* 256 (2004) 705
25. "An Optimization of Process Parameters for Stir Casted Aluminium Metal Matrix Composites to Improve Material Removal Rate", *IJMPERD*, Vol. 9, Issue 5, pp. 951–960
26. "The Processing Techniques and Behaviour of Aluminum Metal Matrix with Different Reinforcement Materials", *IJMPERD*, Vol. 9, Issue 4, pp. 793-804
27. "Corrosion Behavior of Copper–Alumina Nanocomposites in Different Corrosive Media", *International Journal of Mechanical Engineering (IJME)*, Vol. 5, Issue 6, pp. 1-10
28. "Manufacturing of Nano/Micro Composites using Friction Stir Processing", *International Journal of Mechanical Engineering (IJME)*, Vol. 4, Issue 3, pp. 29-48

AUTHORS PROFILE



P. Berlin Push, is a Research Scholar of Department of Mechanical Engineering in Noorul Islam Centre for Higher Education.

Education Details

P. Berlin Push completed his under graduation B.E Mechanical Engineering from Lord Jegannath college of Engineering and Technology and Post Graduation M.E (Thermal Engineering) from Ponjesly College of Engineering.

Publication

Published 1 Technical paper in international Conference.

Achievement

District player in Badminton and received the medal for performing athletic sports.

Research Work

Presently doing Research on Metal Matrix Composite.



Dr. B. Bavanish, is a Associate Professor of Faculty of Mechanical Engineering in Noorul Islam Centre for Higher Education.

Education Details

Dr.B. Bavanish completed his Under Graduation (B.E) in Mechanical Engineering from C.S.I Institute of Technology, affiliated to M.S. University, Tirunelveli and completed his Post Graduation (M.E.) in Computer Integrated Manufacturing from Noorul Islam College of Engineering, affiliated to Anna University, Chennai and Research in the Department of Mechanical Engineering from Anna University, Chennai.

